

Arboviral Disease Surveillance Protocol

Mosquito-borne arboviruses endemic to the U.S. include Eastern equine encephalitis (EEE), LaCrosse encephalitis (LAC), Saint Louis Encephalitis (SLE), West Nile virus (WNV), and Western equine encephalitis. See other material for guidance on non-endemic (e.g., dengue fever) or tick-borne (e.g., Powassan) arboviral infections.

Provider Responsibilities

- 1) Report suspect and confirmed cases of arbovirus infection by completing the provider section of the WVEDSS Arbovirus form. Forward the completed form to the local health department within one week of diagnosis. Include a copy of the laboratory report.
- 2) Assure that a serological or CSF specimen from the patient is referred to the Office of Laboratory Services (OLS) within one week of diagnosis. OLS can be reached at 304-558-3530.
- 3) Note: In West Virginia, appropriate arbovirus testing should include: EEE, LAC, SLE, and WNV. Testing for all four may be performed free-of-charge at the OLS. During June to November, testing is strongly recommended for hospitalized patients with encephalitis.

Laboratory Responsibilities

- 1) Report positive test results for arbovirus to the local health department within 1 week.
- 2) Submit a serological or CSF specimen to the Office of Laboratory Services for confirmation within 1 week.
- 3) Note: In West Virginia, appropriate arbovirus testing should include: EEE, LAC, SLE and WNV. Laboratories that cannot offer complete and appropriate testing can refer specimens directly to the Office of Laboratory Services (OLS) free-of-charge. Call 304-558-3530.

Public Health Action

- 1) Educate the public about mosquito-borne diseases, especially regarding elimination of mosquito breeding sites and use of personal protective measures. Especially in LaCrosse endemic areas, target resources to areas that have experienced cases in the past.
- 2) Educate physicians and hospital infection control practitioners to:
 - a. Recognize clinical syndromes that warrant arbovirus testing (especially hospitalized encephalitis cases during summer and early fall), and
 - b. Order appropriate testing for West Nile virus (WNV), LaCrosse encephalitis (LAC), Eastern equine encephalitis (EEE), and St. Louis encephalitis (SLE).

This action should be accomplished by generating a physician alert from the county health department and/or by asking infection control practitioners to assist in alerting physicians.

- 3) Educate veterinarians to consider WNV and EEE as a possible etiology of summertime encephalitis in horses.
- 4) Educate government officials at all levels regarding mosquito surveillance and integrated pest management as a means of preventing cases of arboviral diseases.
- 5) Maintain a line listing of dead bird reports at the local health department.
 - a. Contact IDEP (800-423-1271) to obtain an ID number to use for sending oral swab samples from recently dead (≤ 24 hours) birds to OLS for WNV, SLE and EEE virus testing.
 - b. Contact the local West Virginia Division of Natural Resources office immediately any time of year to report suspicious clusters of birds.
 - c. Should the avian influenza H5N1 virus be isolated from wild birds or poultry in the Western hemisphere, recommendations may change regarding bird mortality surveillance.
- 6) Report confirmed/probable/suspected human, equine, or avian arbovirus cases urgently to the Division of Infectious Disease Epidemiology (DIDE).
- 7) Investigate cases of human arboviral disease and perform a visit to the homes of all confirmed and probable arbovirus case-patients to:
 - a. Visualize the outdoor environment.
 - b. Educate the family about removal of containers, mosquito habitat abatement, and use of personal protective measures, including use of mosquito repellent.

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- c. Obtain latitude and longitude of the home of the case-patient.
- d. Interview the case-patient (or family members) to obtain information on the location of other potential exposures, including time spent out of doors during the incubation period. Include a travel history during the incubation period.

Document using the Arbovirus WVEDSS Investigation Form. Forward the completed WVEDSS Arbovirus form and paper copies of laboratory reports to DIDE.

- 8) Given existing resources; if bird, human, or equine cases of arboviral disease are identified:
 - a. increase public education to encourage use of personal protective measures,
 - b. increase public education to encourage elimination of mosquito breeding sites,
 - c. increase education of government officials at all levels regarding mosquito surveillance and integrated pest management as a means of preventing additional cases,
 - d. generate an alert to physicians to intensify surveillance for human cases, and
 - e. for cases of EEE and WNV, generate an alert to veterinarians to intensify surveillance for equine cases.
- 9) If additional resources become available:
 - a. establish local or regional mosquito surveillance and control capacity, and
 - b. enhance viral surveillance of mosquito populations.

Prevention Objectives

- 1) Reduce disease risk through public education to encourage:
 - a) use of personal protective measures, and
 - b) elimination of mosquito breeding sites.
- 2) If additional resources become available: reduce disease risk through development of local or regional mosquito surveillance and control capacity.

Disease Control Objectives

- 1) If a bird or equine case is identified: prevent the development of human cases through education of the public to use personal protective measures and eradicate mosquito breeding sites.
- 2) If a human case is identified: prevent the development of additional human cases through education of the public to use personal protective measures and eradicate mosquito breeding sites.

- 3) If positive mosquito pools are identified: prevent the development of human cases through appropriate mosquito surveillance and control, as well as education of the public to use personal protective measures and eradicate mosquito breeding sites.
- 4) If additional resources become available: prevent human cases through development of local or regional mosquito surveillance and control capacity.

Surveillance Objectives

- 1) To monitor arbovirus incidence in West Virginia and document trends by demographics, place and time.
- 2) To detect West Nile virus activity, if present (to be accomplished through dead bird testing).
- 3) Detect equine cases of arbovirus, and characterize by place and time.
- 4) To detect early season human cases of arboviral disease.
- 5) To characterize arbovirus-infected mosquitoes in West Virginia by species, location and type of habitat.
- 6) To identify breeding sites and geographic distribution of mosquitoes that may potentially vector novel or travel-associated arboviruses such as dengue or chikungunya.

Public Health Significance

After its introduction in 1999, West Nile virus expanded its territory across the United States. West Nile called attention to the weakened public health infrastructure for arbovirus surveillance in the United States. Due to this concern, Federal money was allocated to improve public health infrastructure, including laboratory diagnostic and medical entomology capacity. Travel associated outbreaks of chikungunya and dengue virus have further called attention to the possibility of introduction of new arboviruses into the United States.

The occurrence of arboviral disease outbreaks is unpredictable; thus public health officials should remain vigilant for increased activity during the summer months. SLE and EEE can occur in sometimes dramatic outbreaks at lengthy intervals with little or no apparent transmission in intervening years. Here are the types of surveillance that should be performed and the purpose of each type of surveillance:

- 1) **Dead Bird Surveillance:** The purpose of dead bird surveillance is to monitor the presence of WNV, EEE or SLE within the jurisdiction under surveillance. This is accomplished by testing freshly dead birds for WNV, SLE and EEE.
- 2) **Mosquito Surveillance:** Mosquito surveillance is conducted to identify mosquito breeding sites and prioritize sites for abatement, and determine if disease-carrying adult mosquitoes are present.
- 3) **Equine Surveillance:** Horses may serve as an important indicator of WNV and EEE activity in the jurisdiction.
- 4) **Human Surveillance:** The purpose of human surveillance is to detect human arbovirus infection within the jurisdiction.

Regardless of the type of surveillance performed, the information collected should be used to prevent further human cases of disease.

The ecology and public health aspects of arboviruses are complex. West Virginia public health officials are encouraged to take the necessary time to educate themselves about these diseases.

In West Virginia, the major arbovirus of concern is LAC; although WNV has occurred in our state in the recent past. SLE and EEE also occur in Eastern states. Birds positive for EEE were identified in 2002. Twenty-four human cases of SLE were reported from West Virginia between 1964 and 2008. See Figure 1.

Mosquito-borne diseases occur in the late summer and fall. Figure 2 demonstrates this characteristic pattern for West Nile virus in the United States. The seasonal occurrence of LAC in West Virginia is similar. The seasonal curve for LAC and other data may be found at: <http://www.wvdep.org/Portals/31/Reports/2008%20Annual%20Report/LaCrosse.pdf>. Because of the seasonal nature of the disease, enhanced passive surveillance for arbovirus is extremely important to improve provider detection and reporting of this disease.

Figure I County-Specific Incidence of Arboviral Encephalitides in the United States, 1999-2007

(Am J Trop Med Hyg, 2008; 79:974-79.)

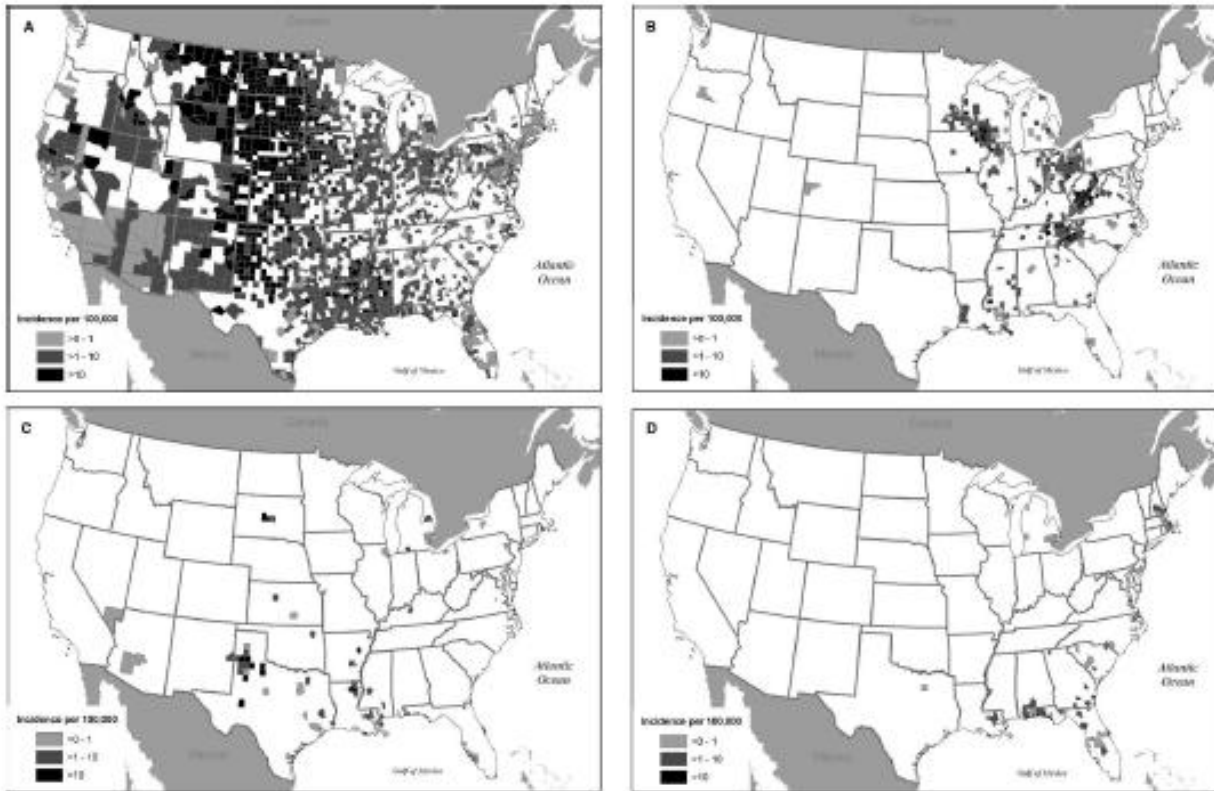
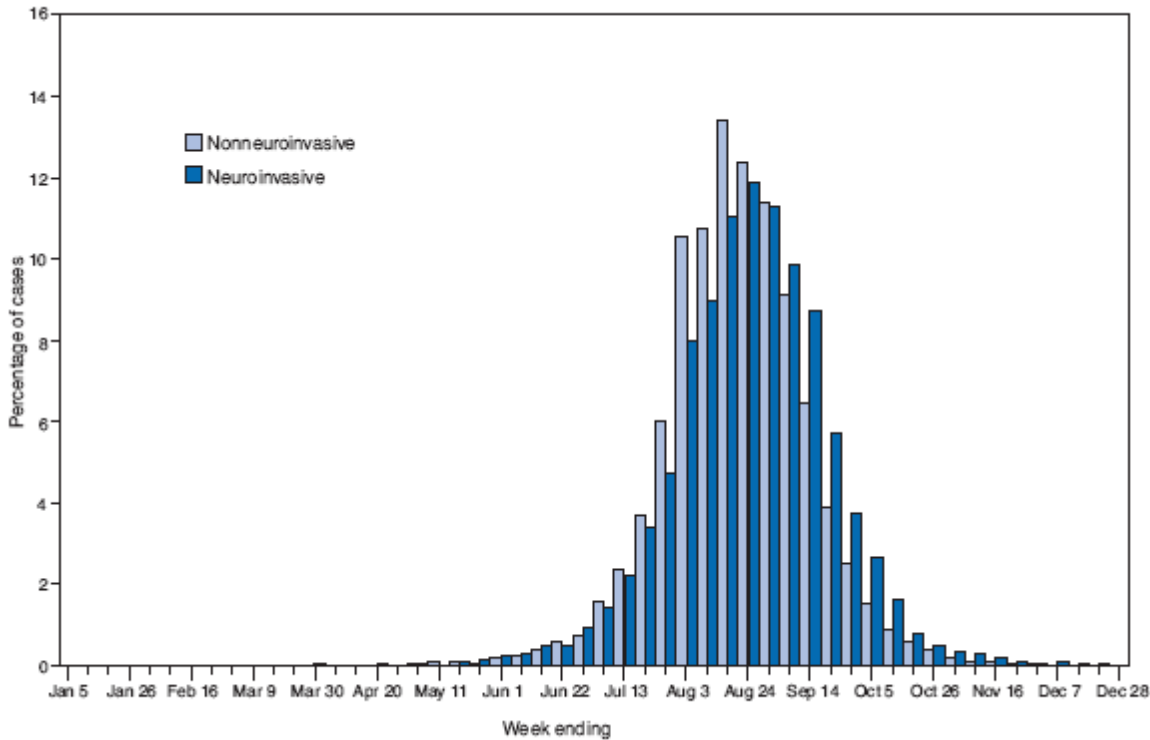


FIGURE 1. Cumulative incidence of neuroinvasive arboviral disease reported in the United States from 1999 to 2007, by county. (A) West Nile virus (WNV), (B) California (CAL) serogroup viruses, (C) St. Louis encephalitis virus (SLEV) and (D) eastern equine encephalitis virus (EEEV).

Figure 2 Seasonal Occurrence of West Nile virus disease, United States, 1999-2008. (MMWR, 2010, 59 (No. SS-2))

FIGURE 2. West Nile virus disease cases (N = 28,961), by week of illness onset — United States, 1999–2008



Clinical Description

Arboviral diseases are clinically indistinguishable from one another. They vary in terms of severity, long-term sequelae and the age groups most heavily affected. The most common manifestation is asymptomatic infection for WNV, LAC and SLE; while EEE is noteworthy for its low case-infection ratio and its high case-fatality rate. Other common clinical syndromes include 1) undifferentiated febrile illness, also referred to as 'febrile headache;' and 2) CNS infection, including aseptic meningitis, encephalitis or myelitis. Clinical presentations with nervous system involvement can be particularly variable and may involve the brain, spinal cord or nerves. The patient may present with syndromes mimicking a stroke or Parkinsonism, as well as tremors, movement disorders, neuritis, acute flaccid paralysis and/or SIADH.

First, some definitions:

Acute flaccid paralysis: sudden onset of muscle weakness with hyporeflexia (decreased muscle reflexes) due to peripheral nerve or spinal cord involvement.

Aseptic meningitis: Symptoms of meningitis include fever, headache, photophobia, stiff neck and vomiting. Persons with aseptic meningitis have greater than 5 white blood cells in the spinal fluid and negative

bacterial cultures. Meningitis means ‘inflammation of the meninges.’ Meninges are the membranous lining around the brain. Aseptic means that there are no bacteria found (in the spinal fluid).

Encephalitis: literally means ‘inflammation of the brain.’ These persons have fever and signs of central nervous system involvement, including: seizures, altered mental status, muscle weakness, sensory loss, or even movement disorders. On CT or MRI, focal or generalized swelling of the brain may be identified.

Febrile headache: is a self-limited illness characterized by fever and headache. Other signs and symptoms associated with this syndrome may include: rash, arthritis, weakness, vomiting and lymphadenopathy.

Myelitis: literally inflammation of the spinal cord. The spinal cord contains nerve fibers that support motor and sensory function. Myelitis results in weakness or paralysis, sensory changes and impaired bowel or bladder function.

Neuritis: literally inflammation of a nerve. Peripheral nerves are those outside of the brain or spinal cord. Neuritis prevents the nerve from functioning normally, so the person with neuritis may lose sensory (feeling, seeing, etc.) or motor (moving) function.

Parkinson’s Disease: is a neurological disorder characterized by tremor, difficulty walking, movement and coordination. Parkinsonism refers to any condition that causes a movement disorder similar to Parkinson’s Disease.

SIADH: Syndrome of inappropriate antidiuretic hormone results in hyponatremia (low blood sodium) due to excessive secretion of antidiuretic hormone.

While there is no way to clinically distinguish one arboviral infection from another, the arboviruses result in illness of varying clinical severity. This is illustrated in Table I below:

Table I Clinical Features of Arboviral Encephalitides

Virus	Case-Fatality Rate	Prevalence of Neurological sequelae	Age Groups Most Affected
Eastern equine encephalitis	36% to 70% of symptomatic cases	35% of surviving symptomatic cases	Children and the elderly
LaCrosse encephalitis	< 1% of all infections; ≈ 1% of hospitalized cases	3% to 12% of hospitalized cases	Children less than age 15
St. Louis encephalitis	< 1% of all infections; 3% to 30% among symptomatic cases (higher in the elderly)	Unknown	Infants and elderly
West Nile encephalitis	< 1% of all infections; 12% to 14% among hospitalized cases (higher in the elderly)	Up to 50% of hospitalized patients at one year followup	Elderly

Etiologic Agent

Table II Etiologic Agent for Arboviral Encephalitides

Virus	Etiologic Agent
Eastern equine encephalitis	family <i>Togaviridae</i> , genus <i>Alphavirus</i>
LaCrosse encephalitis, or California sergroup	family <i>Bunyaviridae</i>
Saint Louis encephalitis	<i>flavivirus</i> related to Japanese encephalitis virus
West Nile virus	family <i>Flaviviridae</i> (genus <i>Flavivirus</i>)
Western equine encephalitis	family <i>Togaviridae</i> , genus <i>Alphavirus</i> ; closely related to EEE and Venezuelan equine encephalitis virus

Reservoir

Table III Reservoir for Arboviral Encephalitides

Virus	Reservoir
Eastern equine encephalitis	Birds
LaCrosse encephalitis	Chipmunks, squirrels
Saint Louis encephalitis	Birds
West Nile virus	Birds, particularly the American crow, blue jay and other corvids and raptors

Reservoir species develop sufficiently high viremia that a mosquito can pick up virus from a blood meal. Horses and humans develop only low-level viremia and are referred to as ‘dead-end’ hosts, meaning they are not important in transmission to other species.

Modes of Transmission

By definition, arboviruses are spread through the bite of an infected mosquito. Important mosquito species are listed in the table below:

Table IV Mosquito Species Responsible for Transmission of Arboviral Encephalitides

Virus	Mosquito species important for transmission to humans, horses
Eastern equine encephalitis	<i>Aedes</i> , <i>Coquillettidia</i> , <i>Culex</i> species
LaCrosse encephalitis	<i>Ochlerotatus (Aedes) triseriatus</i> <i>Stegomyia albopicta</i>
Saint Louis encephalitis	<i>Culex</i> species
West Nile virus	<i>Culex</i> species

Five additional routes of infection for West Nile include transplantation, transfusion, breastfeeding, transplacental and occupational (laboratory workers). These modes of transmission represent a very small proportion of cases.

There is no documented evidence of direct person-to-person or animal-to-person transmission of arboviruses. There is a theoretical concern that a person may get WNV from handling live or dead infected birds, so people should avoid bare-handed contact when handling dead animals, and use gloves or double plastic bags to place carcasses in garbage cans. People should ALWAYS wash hands after handling a sick or dead animal.

Incubation Period

Table V Incubation Period for Arboviral Encephalitides

Virus	Incubation period, days
California encephalitis	5-15
Eastern equine encephalitis	3-10
St. Louis encephalitis	4-14
Western equine encephalitis	2-10
West Nile encephalitis	5-15

Infectious Period

There is no direct person-to-person transmission of these viruses. See section on Modes of Transmission above.

Outbreak Recognition

Any case of human or equine WNV, SLE or EEE is defined as an outbreak, because of low baseline incidence. La Crosse is endemic in parts of West Virginia, so an outbreak of LAC is defined as cases over and above the expected or encroachment into an area of the state not previously known to have cases. Infectious Disease Epidemiology should be notified immediately about outbreaks.

Case Definition

2004 Case Definition

Clinical description

Arboviral infections may be asymptomatic or may result in febrile illnesses of variable severity sometimes associated with central nervous system (CNS) involvement. When the CNS is affected, clinical syndromes include aseptic meningitis, myelitis and encephalitis, which are clinically indistinguishable from similar syndromes caused by other viruses. Arboviral meningitis is usually characterized by fever, headache, stiff neck, and pleocytosis in cerebrospinal fluid. Arboviral myelitis is usually characterized by fever and acute bulbar or limb paresis or flaccid paralysis. Arboviral encephalitis is usually characterized by fever, headache, and altered mental status ranging from confusion to coma with or without additional signs of brain dysfunction. Less common neurological syndromes can include cranial and peripheral neuritis or other neuropathies, including Guillain-Barré syndrome.

Non-neuroinvasive syndromes caused by these usually neurotropic arboviruses can rarely include myocarditis, pancreatitis, or hepatitis. In addition, they may cause febrile illnesses (e.g., West Nile fever [WNF]) that are non-localized, self-limited illnesses with headache, myalgias, arthralgias, and sometimes accompanied by skin rash or lymphadenopathy. Laboratory-confirmed arboviral illnesses lacking documented fever can occur, and overlap among the various clinical syndromes is common.

Clinical criteria for diagnosis

Cases of arboviral disease are classified either as neuroinvasive or non-neuroinvasive, according to the following criteria:

Neuroinvasive disease requires the presence of fever and at least one of the following, as documented by a physician and in the absence of a more likely clinical explanation:

- Acutely altered mental status (e.g., disorientation, obtundation, stupor, or coma), or
- Other acute signs of central or peripheral neurologic dysfunction (e.g., paresis or paralysis, nerve palsies, sensory deficits, abnormal reflexes, generalized convulsions, or abnormal movements), or
- Pleocytosis (increased white blood cell concentration in cerebrospinal fluid [CSF]) associated with illness clinically compatible with meningitis (e.g., headache or stiff neck).

Non-neuroinvasive disease requires, at minimum, the presence of documented fever, as measured by the patient or clinician, the absence of neuroinvasive disease (above), and the absence of a more likely clinical explanation for the illness. Involvement of non-neurological organs (e.g., heart, pancreas, liver) should be documented using standard clinical and laboratory criteria.

Laboratory criteria for diagnosis

Cases of arboviral disease are also classified either as confirmed or probable, according to the following laboratory criteria:

Confirmed case :

- Four-fold or greater change in virus-specific serum antibody titer, or
- Isolation of virus from or demonstration of specific viral antigen or genomic sequences in tissue, blood, CSF, or other body fluid, or
- Virus-specific immunoglobulin M (IgM) antibodies demonstrated in CSF by antibody-capture enzyme immunoassay (EIA), or
- Virus-specific IgM antibodies demonstrated in serum by antibody-capture EIA and confirmed by demonstration of virus-specific serum immunoglobulin G (IgG) antibodies in the same or a later specimen by another serologic assay (e.g., neutralization or hemagglutination inhibition).

Probable case :

- Stable (less than or equal to a two-fold change) but elevated titer of virus-specific serum antibodies, or
- Virus-specific serum IgM antibodies detected by antibody-capture EIA but with no available results of a confirmatory test for virus-specific serum IgG antibodies in the same or a later specimen.

Case definition

A case must meet one or more of the above clinical criteria and one or more of the above laboratory criteria.

Comment

Because closely related arboviruses exhibit serologic cross-reactivity, positive results of serologic tests using antigens from a single arbovirus can be misleading. In some circumstances (e.g., in areas where two or more closely related arboviruses occur, or in imported arboviral disease cases), it may be epidemiologically important to attempt to pinpoint the infecting virus by conducting cross-neutralization tests using an appropriate battery of closely related viruses. This is essential, for example, in determining that antibodies detected against St. Louis encephalitis virus are not the result of an infection with West Nile (or dengue) virus, or vice versa, in areas where both of these viruses occur. Because dengue fever and West Nile fever can be clinically indistinguishable, the importance of a recent travel history and appropriate serologic testing cannot be overemphasized. In some persons, West Nile virus-specific serum IgM antibody can wane slowly and be detectable for more than one year following infection. Therefore, in areas where West Nile virus has circulated in the recent past, the co-existence of West Nile virus-specific IgM antibody and illness in a given case may be coincidental and unrelated. In those areas, the testing of serially collected serum specimens assumes added importance.

The seasonality of arboviral transmission is variable and depends on the geographic location of exposure, the specific cycles of viral transmission, and local climatic conditions. Reporting should be etiology-specific (see below; the six diseases printed in bold are nationally reportable to CDC):

St. Louis encephalitis virus disease

West Nile virus disease

Powassan virus disease

Eastern equine encephalitis virus disease

Western equine encephalitis virus disease

California serogroup virus disease (includes infections with the following viruses: California encephalitis, Jamestown Canyon, Keystone, La Crosse, snowshoe hare, and trivittatus)

Note: Due to the continued risk of unintentional or intentional introduction of exotic arboviruses into the United States (e.g., Venezuelan equine encephalitis virus), or the reemergence of indigenous epidemic arboviruses (e.g., St. Louis encephalitis and western equine encephalitis viruses), physicians and local public health officials should maintain a high index of clinical suspicion for cases of potential exotic or unusual arboviral etiology, and consider early consultation with arboviral disease experts at state health departments and CDC.

Laboratory Diagnosis

Human Serological Testing

Serum or CSF should be sent to the West Virginia Office of Laboratory Services (OLS), 167 11th Ave, South Charleston, WV 25303 for testing or confirmation. Call 304-558-3530 to arrange testing. Specimens should be accompanied by a completed Arbovirus Test Submission Form when sent to the OLS.

Dead Bird Testing

Arbovirus activity can be monitored through detection of arboviral RNA in oral pharyngeal swab samples taken from dead birds. If a cluster of more than two birds of any species is detected then contact local DNR and the DIDE epidemiologist on call. In consultation with DNR / DIDE, collect a representative sample of birds for testing. Oral pharyngeal swab collection information and submission forms are available on OLS's Website at www.wvdhhr.org/labservices through their A-Z link. Before submitting dead birds for testing, call **DIDE (304-558-5358 or 800-423-1271)** to obtain a West Virginia ID number.

Preventive Interventions

There is currently no vaccine against human arboviruses, and treatment is supportive.

Repellants such as DEET, oil of lemon eucalyptus, IR3535 and picaridin have demonstrated efficacy against mosquitoes.

Share these prevention messages with the public:

1. Empty standing water in old tires, cemetery urns, buckets, plastic covers, toys, or any other container where mosquitoes may breed.

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2. Empty and change the water in bird baths, fountains, wading pools, rain barrels, and potted plant trays at least once a week if not more often.
3. Drain or fill temporary pools with dirt.
4. Keep swimming pools treated and circulating, and rain gutters unclogged.
5. Use mosquito repellents according to the label directions. Apply sparingly to children before they play out of doors, and rinse children off with soap and water when they come back in. Do not apply repellent to the face and hands of young children because they may rub it in their eyes. Follow label directions and precautions closely.
6. Use head nets, long sleeves, and long pants if you venture into areas with high mosquito populations.
7. Make sure window and door screens are “bug tight.”

Surveillance Indicators

1. Number of dead birds submitted per county for testing for arboviruses.
2. Presence of mosquito data for the state.
3. Proportion of cases with complete clinical investigation: Patient demographics, involvement in outdoor activities, travel history and clinical symptoms
4. Proportion of cases with home visit completed for environmental evaluation, including GIS coordinates of location, patient and family education.

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